US Army Corps
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Kansas City District
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McCONNELL AIR FORCE BASE, WICHITA, KANSAS

CORROSION CONTROL FACILITY, PHASE I

GEOTECHNICAL REPORT

June 2003

**Submitted by the US Army Corps of Engineers, Kansas City District
Geotechnical Design and Dam Safety Section, EC-GD**

TABLE OF CONTENTS

GEOTECHNICAL REPORT

Corrosion Control Facility, Phase I
McConnell Air Force Base, Wichita, Kansas
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1. SCOPE AND INTRODUCTION

1.1 Introduction

This Geotechnical Report presents the results, observations, and recommendations related to subsurface investigations conducted for the Corrosion Control Facility, Phase I project (CCF). Provided in this report are results of the subsurface investigations and recommendations for site preparation, types of foundations required for construction, foundation design parameters, the identification of special precautions necessary in the design of foundations due to observed conditions, and pavement sections.

1.2 References

ASTM D 1557-00	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft^3 (2,700 kN-m/m^3)).
ASTM D 1586-99	Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.
ASTM D 1587-00	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.
ASTM D 2166-00	Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.
ASTM D 2216-98	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D 2487-00	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
ASTM D 2488-00	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D 2922-00	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

ASTM D 2937-00 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

ASTM D 3017-96 Standard Test Method for Water Content of Soil and Rock in Place By Nuclear Methods (Shallow Depth).

ASTM D 4318-00 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

ASTM D 4546-96 Standard Test Methods for One-Dimensional Swell or Settlement Potential of Cohesive Soils.

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U.S. Army Corps of Engineers; TM 5-818-7; "*Foundations in Expansive Soils*;" September 1983.

U.S. Army Corps of Engineers; TM 5-818-1; "*Soils and Geology: Procedures for Foundation Design of Buildings and Other Structures (Except Hydraulic Structures)*;" October 1983.

U.S. Army Corps of Engineers; TM 5-822-5; "*Pavement Design for Roads, Streets, Walks, and Open Storage Areas*;" June 1992.

Zeller, D.E., ed, 1968; "*The Stratigraphic Succession in Kansas*"; Kansas Geological Survey Bulletin 189; University of Kansas Publications, Lawrence, KS.

1.3 Project Description

The CCF project involves construction of the following structures:

- POL Operations Building. This structure is to be a one-story structure used to house the control center for aircraft ground refueling activities. The structure is to be rectangular with approximate dimensions of 56 x 80 feet. It is planned to contain 4 office spaces, a laboratory, ready room, break room, communications room, mechanical room, and men's and women's restrooms. The structure is assumed to be metal framed, have a partial brick exterior veneer, and a metal roof.

- Refueler Truck Maintenance Facility. This generally rectangular structure is to be used to house aircraft fuel hauling vehicle's servicing facilities. It is planned with approximate dimensions of 124 x 49 feet. The facility will have three, side by side, high bay truck service stalls and one high bay wash stall. Between the service and wash stalls are located 2 offices, tool room, equipment storage room, and mechanical room. The structure is assumed to be metal framed, have a partial brick exterior veneer, and a metal roof.

- Fuel Pump Island Cover. This structure is to consist of a metal "overhead" covering a fuel dispensing island. The cover has plan dimensions of approximately 45 x 60 feet. The fuel dispensing island extends along the midpoint of the 60 foot side. When in use, two refueler vehicles will be able to park on either side of the island to pump fuel yet remain under the cover. This structure is to be supported by four columns, one at each of the overhead's corners.

All structures are located immediately south of the flightline near the eastern end of the runway.

A number of pavement structures are also to be constructed as part of this project's Scope of Work. The largest is to be a refueler truck parking facility to be constructed around the Refueler Maintenance Facility building. The area is to be surfaced with Portland Cement Concrete (PCC). A new access loop, to be constructed to and through the Fuel Pump Island, is also to be surfaced with PCC. Some existing PCC roadways to be incorporated into the design of this new loop road are to be slightly widened to ease vehicle flow. Widening will involve new PCC to expand existing lane widths and turning radii. Also associated with this project will be various PCC sidewalks and PCC support pads for garbage dumpsters.

The existing refueler truck parking pad is to be converted, at least temporarily, into parking for cars and light trucks. The existing facility is Asphaltic Concrete (AC) surfaced. This area was investigated during the subsurface exploration program but no work is deemed required at this time to convert the facility to its new usage. A large portion of this existing parking area will be removed during the Phase II portion of the CCF project to make way for a new corrosion control aircraft hanger. Finally, existing AC surfaced roadways damaged or destroyed by construction activities will require replacement in kind at the end of the construction period.

2. SUBSURFACE AND LABORATORY INVESTIGATION

2.1 Subsurface Investigation

The CCF subsurface investigation was conducted during early 2003. Subsurface conditions for the complex were investigated by advancing 5 new borings (ADU-03-01 through ADU-03-05), 19 cone penetrometer (CPT) pushes (03C0 through 03C8, 03C12 through 03C14, and 03C17 through 03C23), examining logs of past borings advanced in the general region, and performing a review of available literature of past, nearby projects. Borings were drilled using 95-mm (3.7-inch) ID hollow-stem augers advanced to a final depth of 35 feet below existing ground surface (bgs) or to auger refusal, whichever first occurred. CPT pushes were advanced to depths of 15-feet bgs or to cone refusal, whichever first occurred. Table 1 defines the boring parameters in reference to the boring name prefix. Boring logs were completed in English units and converted to metric units during analysis. Drawings BL1.1 to BL1.2, included in Attachment A, presents the boring locations. Boring strip logs and CPT plots are included on Drawings LB0.2 to LB0.3.

Table 1: Drilling Equipment for Subsurface Explorations

Boring Designation Number Prefix	Boring Advancement Method(s)	Type(s) of Sampling Attempted
03C	1. 1.41-inch diameter cone penetrometer for all pushes except 3, 4, 8, 13, and 14 where a 1.71-inch diameter cone was used.	1. Sampling not attempted with cone penetrometer.
ADU	1. 3.75-inch ID Hollow-Stem Auger. 2. Standard Penetration Test Drive. 3. 5-inch diameter Shelby-tube undisturbed pushes.	1. Standard Penetration Test with jar samples. 2. Shelby tube samples with accompanying jar samples at top and/or bottom of push.

In-situ Standard Penetration Tests (SPTs) were performed as indicated in Table 2 in accordance with ASTM D 1586 at predetermined depths for each exploration boring. The number of blows required to drive a split-spoon sampler each of three 152.4-mm (6-inch) increments of the total 0.5-meter (1.5-foot) drive length using a standard 63.5-kg (140-pound) hammer dropping 762-mm (30-inches) were recorded on the boring logs. Each SPT was driven to the full 0.4572-m (1.5-foot) maximum drive depth or to refusal, whichever first occurred. SPT refusal is defined as reaching an SPT blow count of 50 in less than 152.4-mm (6-inches) of drive penetration. Disturbed samples of subsurface materials were obtained using a 34.9-mm (1.4-inch) inside diameter SPT sampler. Material collected by the sampler was transferred into labeled glass jars for storage and transported to the soils laboratory for testing.

Ground water was encountered in borings ADU-03-1 through ADU-03-5. Ground water elevations at the time of drilling are shown on the borings logs presented in Appendix A. During drilling ground water elevations varied from 1 meter to 5 meters below ground surface. All borings were backfilled with cement bentonite grout prior to leaving each drill site.

Undisturbed samples were collected in general accordance with ASTM D 1587 using a 127-mm (5-inch) diameter, thin walled, fixed piston sampling tube (Shelby sampler). Samples of the material recovered with the Shelby tube sampler were extruded in the field and torvane tests performed at the top, mid-point, and bottom of each 609.6-mm (2-foot) long sample. Each sample was double wrapped in aluminum foil and sealed with wax within cardboard tubes for storage and transport to the testing laboratory.

All sampled material was classified in general accordance with methods defined in TM-818-1. Soils encountered in borings and soils tested in the laboratory were classified according to the Unified Soils Classification System (USCS), ASTM D 2487. Bedrock encountered in borings was classified according to geologic methods. Bedrock found to be highly weathered to decomposed into a soil-like consistency was further described on the boring logs using terminology appropriate to the material when viewed as a soil.

Differences may exist between laboratory classifications of the samples and classifications as seen on the boring logs. The differences should be taken as variations in the classification techniques used by two professional disciplines for the description of the same material. Therefore, as an example, a decomposed shale bedrock as noted in the logs and a highly plastic clay (CH, USCS) as noted in the laboratory test results for a sample obtained from the same boring at the same depth interval represent the same material.

2.2 Laboratory Analysis

A total of 54 soil samples were provided to Geotechnology, Inc. for analysis. Disturbed samples consisted of 35 jar samples and 5 paper bag samples. Undisturbed samples consisted of 14 Shelby tube samples. Representative soil samples were selected for laboratory analysis during the subsurface investigation program. Specific tests include visual classification, Atterberg Limits (liquid and plastic limits), hydrometer test, natural water content, dry unit weight, unconfined compression, and one-dimensional consolidation with swell. Total sulphates and soil pH were also requested. Pace Analytical Laboratory of Lenexa, Kansas performed these chemical tests on some samples to support pavement designs. Jar samples were grouped in to like soils. Representative samples from each group were visually classified and subjected to Atterberg Limits test. Six unconfined compression and six consolidation tests were performed on the undisturbed Shelby tube samples. Laboratory test results are presented in Appendix B.

3. SITE AND SUBSURFACE CHARACTERIZATION

3.1. Geologic Setting

McConnell Air Force Base is located on the southeast edge of Wichita, Sedgwick County, Kansas, in the south central part of the state. Wichita is located within the Osage Plains Section of the Central Lowland Province: part of a larger, major physiographic division known as the Interior Plains. The nearly flat-lying sedimentary rocks underlying this area exhibit a regional dip toward the southwest at an estimated slope of about 1.9 meters per kilometer (10 feet per mile). Ground elevations on the airbase range from 397.7 meters (1305 feet) msl (above mean sea level) in a draw at the extreme southwest corner of the base to 420.6 meters (1380 feet) msl toward the northwest corner. The youngest bedrock underlying the airbase is the Wellington Formation, formed during the Paleozoic Era's Permian Period. The Wellington is chiefly composed of shale with some limestone, gypsum, and anhydrite interbeds. Thick beds of halite are present at depth within this formation. Overlying the Wellington are wind deposited loess deposits of silt and sand, Illinoian to recent in age. The western two-thirds of Wichita lies in the southerly trending, 9.7-kilometer (6-mile) wide Arkansas and Little Arkansas River valley. The rivers’ confluence is located in the northwestern part of the City of Wichita, about 8.05-kilometers (5-miles) northwest of the airbase.

3.2. Seismic Conditions

In reference to data published in Department of the Army, USACE TI 809-04, dated December 1998, and IBC 2000, McConnell Air Force Base lies within the seismic probability area described as Zone 1. This indicates that should a seismic event occur in the vicinity, it would likely exhibit an intensity such that minor damage to structures would be expected. The short period spectral acceleration coefficient for design purposes, (defined as the 2500-year return period event, having 2% probability of exceedance in 50 years) S_s, is 0.14g and the one-second period spectral acceleration coefficient, S_1, is 0.06g. The project should be designed using a site class “E”.

3.3. Site Description

The area of the proposed Corrosion Control Facility project is roughly bounded by existing buildings 1129, 1101, 981, and 950 in the general vicinity of the intersection of Topeka and Independence Streets on McConnell Air Force Base. The site is semi-developed with tanks and existing buildings surrounding the construction area. Topography is flat with minimal vegetation, consisting primarily of lawn grass.

3.4. Subsurface Conditions

Subsurface conditions as determined during the site subsurface exploration and laboratory testing programs are presented in the following paragraphs.

Soil deposits underlying proposed construction site as identified during the subsurface exploration program consist of highly plastic clay overlying weathered to decomposed bedrock. Laboratory test results indicate that the clay is fairly uniform in makeup and exhibited soil properties. A general soil profile can be constructed as follows:

- A thin, surficial layer (less than 150-mm [6-inches]) of organic-rich topsoil; and,
- Approximately 2.7 to 2.9-meters (8.9 to 9.5-feet) of highly plastic residual clay (CH, USCS) directly overlying weathered to decomposed bedrock.
- A layer of fill was encountered in ADU-03-1 below the asphalt to a depth of approximately 2 meters (6.5 feet).

Moisture contents were performed on jar and undisturbed Shelby samples. Natural moisture content of the soil at the time of drilling ranged from 11.1 percent to 30.6 percent. Liquid limits of the clay layer ranges from 39 to 84 and plastic limits ranged from 15 to 30 with the averages being 60 and 21 respectively. Plastic Index ranges between 22 and 57 with an average of 39. Two hydrometer tests were performed on samples from ADU-03-2 and ADU-03-5 at depths of 1.5 meters (5 ft) and 4.5 meters (15 ft). Percent passing the 200 sieve was 97% and 87% respectively.

The clay soils were predominately stiff with intermittent soft layers at the time of sampling, with unconfined compression tests ranging from 46 kPa to 159 kPa. The weathered bedrock was stiff (relative to soil classification) with N values ranging from 11 to 64. Borings ADU-03-4 and ADU-03-5 encountered SPT refusal at 11 meters (36 ft) below ground surface.

Six, one-dimensional consolidation tests were performed on undisturbed samples of clay in accordance with ASTM D 4546 method C. Preconsolidation stresses ranged from 105 kPa (2200 psf) to 268 kPa (5600 psf). Uncorrected swell pressures ranged from 24 kPa (500 psf) to 48 kPa (1000 psf).

Testing was performed to identify sulphates in the soil. Test results ranged from 20 parts per million to 260 parts per million. The levels of sulphates at the site are under levels that complicate lime modification of the soil. However, gypsum has been identified in the soils at McConnell AFB on previous projects. Gypsum is calcium sulphate, which reacts with lime causing the soil to swell.

4. DISCUSSIONS AND DESIGN RECOMMENDATIONS

4.1 Site Preparation

Site preparation for buildings is to include the removal of existing vegetation, stumps, roots, pavements, base course materials, concrete curbs and gutters, underground utilities, and other deleterious materials to at least five feet outside of the building pad limits. Voids created by the removal of these materials are to be filled with compacted fill. All existing topsoil is to be removed and stored in a designated area until the completion of the project. Prior to placement of the first lift of fill, native soils are to be scarified to a depth of 150-mm (6-inches) and compacted to the proper moisture and density. Any voids created by removal of foundation elements or clearing and grubbing should be filled with properly compacted engineered fill.

Sloped surfaces steeper than one vertical to four horizontal are to be benched or stepped prior to the placement of any new fill. Borrow material for the construction of engineered fill will need to be obtained from an approved source off the limits of government property. Satisfactory and unsatisfactory materials are to be classified according the Unified Soils Classification System (USCS) criteria. Satisfactory materials include the USCS classifications GW, GP, GM, GC, SP, SW, SM, SC, ML, CL, and CH. Unsatisfactory materials include the USCS classifications MH, Pt, OH, and OL. Unsatisfactory materials also include debris, refuse, roots, organic matter, frozen material, and stones larger than 75-mm (3-inches) in diameter. Soil-like materials obtained from the excavation, e.g. intensely weathered bedrock such as sandstone, limestone, and/or shale, will not be considered as satisfactory for use as borrow.

Select material is to consist of natural sand and gravel, crushed rock, manufactured sand, or quarry fines that have a maximum particle size of 25-mm (1-inch) and 15 to 50 percent passing the #200 sieve. The portion of the material passing the #40 sieve is to either be non-plastic or have a plasticity index equal to or less than 12. Select material is to be compacted to at least 95 percent of the maximum density based on ASTM D 1557.

Materials placed as engineered fill is to be placed in uncompacted lifts not to exceed 8-inches in thickness. Compaction is to be accomplished by approved equipment well suited to the material being compacted. All references to compaction percentages included in this section refer to Modified Compaction per ASTM D 1557. Prior to compaction, the moisture content of the cohesive and non-cohesive materials will be adjusted by the construction Contractor to a range of between 0 and +4 percent of optimum moisture (except for expansive clays as described in the following paragraph) either by moistening or aerating as required. Non-expansive cohesive fill is to be compacted to not less than 90 percent of the maximum density as determined by ASTM D 1557. The use of a drying agent (i.e., lime or type-C fly ash) is not recommended. The lime or fly ash can react with sulphates that are present at McConnell causing the soils to swell.

Expansive soils are defined as soils with a plasticity index equal to or greater than 18. Expansive soils are to be compacted to a density of not less than 90 percent nor more than 93 percent of maximum density with a water content between +3 and +8 percent of optimum as determined by ASTM D 1557.

In-place densities of engineered fill will be determined by the Contractor using ASTM D 1556, ASTM D 2937, or ASTM D 2922 in conjunction with ASTM D 3017. If ASTM D 2922 is used for field density control, there is to be a minimum of one test performed according to ASTM D 1556 for every 10 tests performed according to ASTM D 2922 for verification of results. Field density tests of site grading operations are to be performed at a frequency of not less than one test per every 200 mm (8-inch) lift for every 2000 m^2 (21,500-$feet^2$) of graded area. Field density tests of material placed beneath the building footprint are to be performed at a frequency of not less than one test per each 200 mm (8-inch) lift per 2000 m^2 (21,500 $feet^2$) area. Wall and/or footing backfill is to be tested at a rate of one test per 200 mm (8-inch) lift per 12 linear meters (40 linear feet).

Working surfaces are to be sufficiently sloped to prevent the ponding of water during construction. Excessively wet material will either be aerated or removed from the fill area by the construction Contractor prior to the placement of any subsequent lifts. Frozen material will not be allowed in the fill. Approved compacted fill is to be maintained at the proper moisture and density condition until the overlying slab-on-grade, foundation, or pavement is completed. Areas disturbed during construction are to be recompacted to the specified moisture and density at no cost to the Government. Fill within the building area is to be constructed to the finished grade elevation before foundation elements are placed.

All excavations for walls, footings, utility trenches, etc. require bracing, shoring, flattening or the use of trench boxes per EM 385-1-1, latest edition, to address the safety of workmen, adjacent structures and pavements, and the public. Adequate drainage shall be provided to keep surface water from flowing into open excavations. Depending on the depth of excavation and the length of time the trench is left open, groundwater that has seeped into the excavation may require removal. Variations in the groundwater surface are not unusual in this area relative to antecedent moisture conditions; therefore, the presence of a groundwater surface, if present, will need to be determined by the contractor at the time of construction. The need for dewatering shall be determined at the time of construction.

4.2. Foundation Design

The proposed structures are to be single story structures and are assumed to be metal framed with partial brick veneer and a metal roof. The Fuel Pump Island cover is assumed to be a metal "overhead" covering a fuel dispensing island. These types of structures at McConnell AFB are typically supported on concrete spread and continuous strip footings bearing in the natural clay soils. Foundation designs developed for the CCF project were based on the following rationale:

- Footings should bear on native clays or structural fill. Continuous strip footings should be designed using an allowable bearing pressure of 2000 psf. Spread footings should be designed based on an allowable bearing pressure of 2500 psf.
- Exterior footings should be founded at least 4 feet below the bottom of slabs-on-grade to provide frost protection. Interior footings should be founded a minimum of 3 feet below the bottom of floor slabs.
- Differential and total settlements are not expected to exceed 1 inch when footings are designed in accordance with the allowable bearing pressures stated herein.
- Footing excavations should be observed prior to placement of concrete to confirm that the assumed bearing materials are present and that the excavations are from soft material or water.
- Footing excavations should be filled with concrete as soon as practical after inspection and placement of steel to prevent drying or accumulation of water.
- All floors are to consist of slabs-on-grade that are structurally isolated from adjacent walls to allow for the maximum of potential soil swell/shrink and overall settlement to occur without the occurrence of significant structural damage.
- Actual structural loadings of the proposed structures were not available for use in this foundation design effort.

4.3. Floor Slabs-on-Grade

Floors for project structures are to consist of concrete slabs-on-grade. Loadings are to consist of personnel traffic with standard office-style furnishings. Design parameters for floor slabs are presented below.

A 6-mil thick vapor barrier shall underlie all floor slabs-on-grade. Underlying the vapor barrier shall be 152-mm (6-inches) of open graded crushed rock (capillary water barrier

[CWB]) overlying a minimum of 457-mm (18-inches) of compacted select material as defined in Section 4.1 of this Geotechnical Report. The total fill below all floor slabs-on-grade shall be 609 mm (24 inches).

All interior slabs-on-grade shall be isolated from all load bearing walls and columns using 13.6-kilogram (30-pound) felt. Slabs-on-grade shall be designed using a coefficient of subgrade reaction of 108 kcf.

4.4. Utility System Installation

Construction of subsurface utilities entering/leaving all structures shall be accomplished according to the following:

- All utility trenches are to be completed to a depth such as to allow the placement of the enclosed piping and pipe bedding materials below the local frost depth of 1.2-meters (4.0-feet) bgs.
- Pipe bedding is to consist of material as specified per the pipe manufacturer's recommendations.
- Compaction of the bedding will be performed according to the pipe manufacturer's recommendations.
- Bedding thickness is to be no less than 305-mm (12-inches).
- Activities related to utility trench excavation and utility placement within the prepared trenches are to strictly follow safety requirements of EM 385-1-1, the Corps of Engineers "*Health and Safety Manual*." These requirements include, but are not limited to, trench sideslope angle restrictions; Contractor personnel entry limitations into open, excavated trenches; material stockpiles adjacent to trench edges; equipment operation along the top of trenches; and, protection of employees, site visitors, and the public from inadvertent falls into open trenches.

4.5. Retaining Structures

Free draining granular material shall be used as backfill for all retaining structures erected on this project. Unyielding walls shall be designed using a coefficient of earth pressure at rest of 0.50 assuming the use of free draining sand backfill material. Yielding walls shall be designed using a coefficient of active earth pressure of 0.333 for walls backfilled with free-draining sand. No passive resistance in the upper 1.52-m (5 feet) shall be considered available in the design due to the potential for vertical tension cracking during periods of dry weather. Only half of the total available passive pressure is to be used in the design below the depth of 1.52-m (5 feet). Lateral forces shall be resisted by frictional forces developed along the base of the footing using a coefficient of sliding of 0.30 for concrete in contact with clay materials.

A moist unit weight of 18.9 kN/m^3 (120 pcf) is recommended for use as the weight of cohesionless (select) materials. Backfill materials placed adjacent to footings or behind retaining walls shall be placed in loose lifts that are a maximum of 200-mm (8 inches) in thickness when heavy mechanical tampers are used for compaction, or a maximum of 100-mm (4 inches) when power driven hand compaction equipment is used. Heavy equipment for spreading and compacting backfill shall not be operated closer to the foundation walls or retaining walls than a distance equal to the height of the backfill above the back of the wall or wall footings.

4.6. Roads and Parking Areas

Design parameters for walkways, roads, and parking areas are presented in the following report sections.

4.6.1. Pavement Site Preparation

Topsoil present in areas to receive pavement is to be removed and stored in a designated area until completion of the project. Fill encountered beneath proposed roads and parking areas shall be removed to a minimum depth of 609-mm (2-feet) below the bottom of the proposed pavement and replaced with suitably compacted, satisfactory backfill. EC-GD may request the contractor remove fill deeper than two feet below the bottom of the proposed pavement if necessary to address unforeseen subgrade conditions. After stripping the topsoil and removing fill, the subgrade is to be scarified to a depth of 152-mm (6-inches) and recompacted to the specified density and moisture content prior to the placement of the base coarse or first layer of fill. Satisfactory backfill shall be placed in uncompacted lift thickness not to exceed 203.2-mm (8-inches). Stones having a dimension greater than 76.2-mm (3-inches) in any dimension will not be permitted in the top 609-mm (6-inches) of prepared subgrade. Native clay beneath paved areas is to be compacted to a minimum of 90 percent of the maximum density as determined by ASTM D 1557 methods B, C, or D. The upper 152-mm (6-inches) of pavement subgrade shall be compacted to a minimum of 90 percent for PCC pavements and 95 percent of the maximum density for AC pavements as determined by ASTM D 1557 methods B, C, or D. Frozen materials will not be permitted in the road fill.

Historically high plasticity clay subgrades for pavements at McConnell AFB have proved challenging in obtaining the required density. The use of lime and fly ash to stabilize the high plasticity clays has been avoided due to the presence of sulphates. The use of a geosythetic reinforcement has been employed as well as increasing density with placement of soil lifts. It should also be noted that the high plasticity clays have exhibited some sensitivity (i.e. remolded shear strengths are less than the undisturbed shear strengths).

AC pavement base course shall be compacted to a minimum of 100 percent of the maximum modified proctor density and PCC pavement base course materials to a minimum of 95 percent of the modified proctor maximum density determined according to ASTM D 1557 methods B, C, or D.

In-place field density tests shall be obtained in accordance with ASTM methods D 1556 or D 2922 in conjunction with ASTM D 3017. Field density tests shall be taken at a frequency not less than one test every 836.05 m^2 (1,000 square yards) per lift of subgrade. Material gradation and moisture testing shall be performed at a rate of one test per 382.22 m^3 (500 cubic yards) of material placed. During construction, the working surface shall be sloped to prevent the ponding of water. After completion, newly graded areas shall be protected from traffic and erosion until the surface course has been completed and allowed sufficient time to cure in order to satisfactorily support traffic loadings.

4.6.2. Design Pavement Sections

Pavement structural sections are provided in the following paragraphs.

Portland Cement Concrete Pavements

The program Rigid Road Design (RRD) 805 developed by the US Army Corps of Engineers Waterways Experiment Station was used for the design of this CCF Refueler Truck Parking facility. The design vehicle for the new refueler truck parking area is to be the loaded tanker trucks (group 3 vehicles) with a rate of use of 105 vehicles per day. No tracked vehicles are involved. Input parameters used in the design program are as follows:

- Design Index = 10 (input to account for site and traffic unknowns)
- Pavement Category = ----
- Pavement Class = ----
- Soil Frost Code = 3 (for F3/F4 clay soils)
- Thickness of Non-Frost Base = 8-inches
- Frost Index of Reduction = 25 (program generated)
- Concrete Flexural Strength = 600 pounds per square inch
- Percent Steel in Concrete = 0%

Program Output for Pavement Section Design:

- Design k (At Top of Base) = 48.53
- Design Thickness as Computed = 8.42-inches
- Maximum Joint Spacing = 12.5 to 15-feet
- Minimum Dowel Length = 16-inches
- Maximum Dowel Spacing = 12-inches
- Dowel Diameter = 1.00-inches

PCC Pavement Design Section (as measured from the surface downward):

- Concrete Thickness = 8.5-inches
    - Maximum joint spacing = 15.0-feet
    - Minimum Dowel Length = 16.0-inches
    - Maximum Dowel Spacing = 12.0-inches
    - Dowel Diameter = 1.00-inches
- Base Course = 4.0-inches
- Subbase Course = 4.0-inches

Asphalt Cement Pavements

- Existing asphalt pavements that are damaged during construction shall be replaced "in kind".

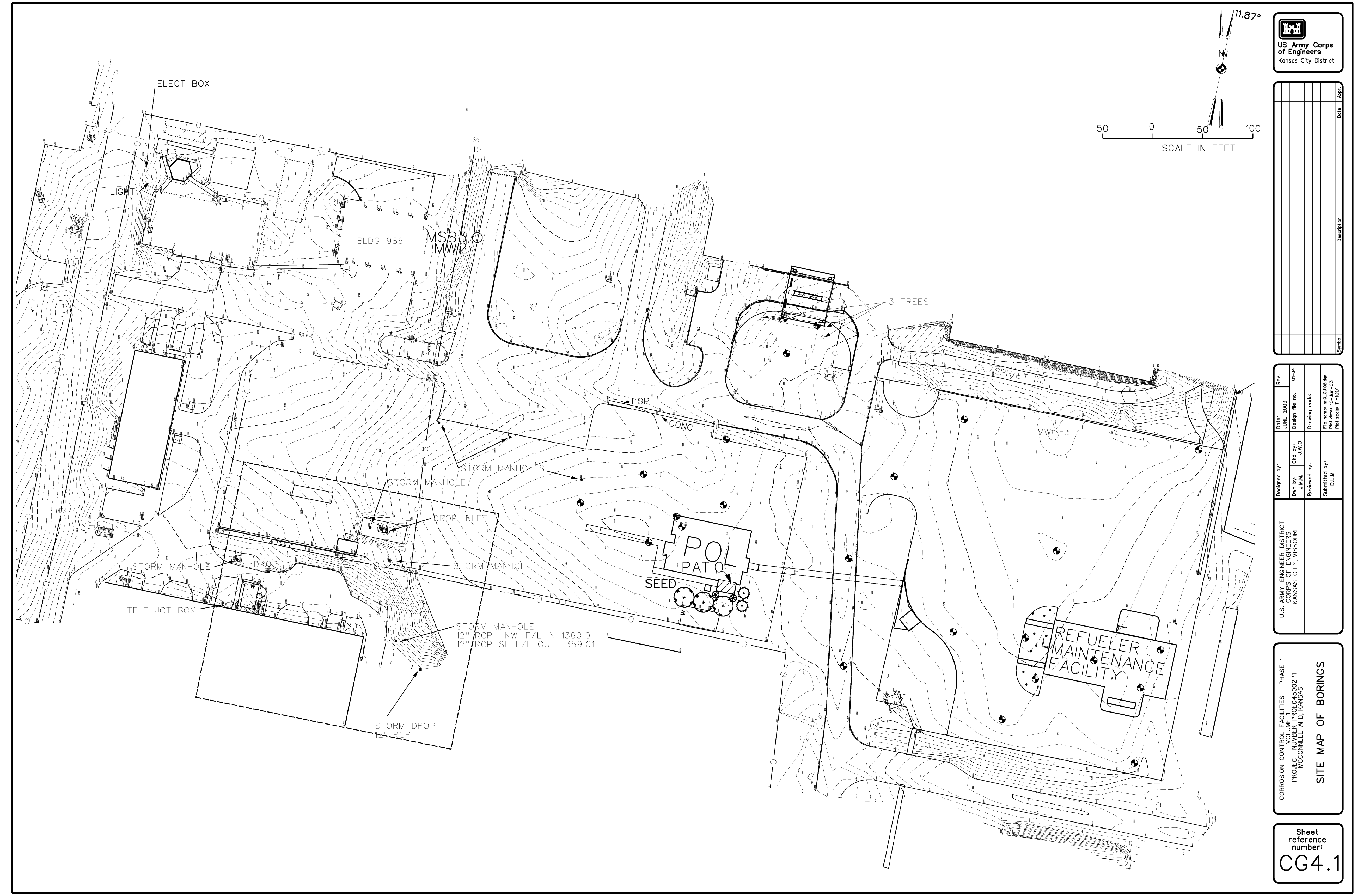
4.7. Special Considerations

Based on Army Technical Manual 5-818-7 Table 4.1 the high plasticity soils located at the project site have a "high" potential for swell. Expansive soils have the potential to exert high pressures on floor slabs and foundation elements due to soil expansion caused by naturally and artificially induced increases in soil moisture content. Similarly, removal of moisture can result in a decrease in soil volume leading to structural effects similar to those that would occur as the result of settlement.

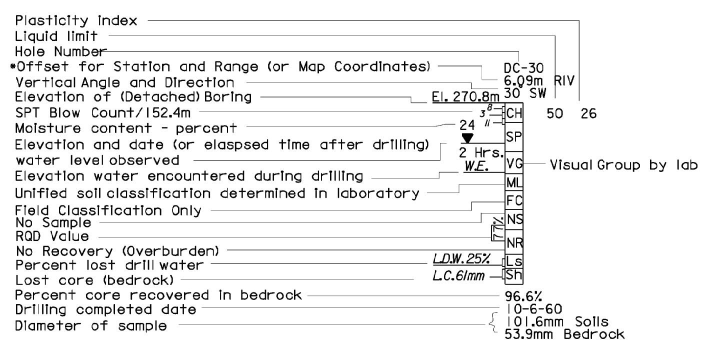
A summary listing of mitigating measures recommended for implementation during construction to minimize the potential effects of expansive soils on the completed structures is provided below. Specifics regarding each item can be found elsewhere in this report.

- The finished grade outside of completed structures is recommended to be sloped a minimum of 5% away from the building for a minimum distance of 3-meters (10-feet) to remove excess surface moisture.
- Extended downspouts are recommended to discharge collected moisture a minimum of 3 meters (10-feet) away from each structure's exterior walls. Care is required to ensure that discharged waters do not flow back toward the building from which it came or to adjacent buildings.
- It is recommended that shrubbery and trees placed as landscaping be maintained a distance from outside walls equal to the mature growth perimeter of the planting plus a distance of 1.5 meters (5-feet) to minimize the removal of moisture from the soil through evapotranspiration and the subsequent shrinkage of soil away from foundation elements and from beneath floor slabs-on-grade.

APPENDIX A – Site Plans and Boring Logs


ELECT BOX
LIGHT
BLDG 956
MSS3-O
MW12
3 TREES
EX.ASPHALT RD
MW-3
EOP
CONC
STORM MANHOLES
STORM MANHOLE
DROP INLET
STORM MANHOLE
DROP
STORM MANHOLE
TELE JCT BOX
STORM MANHOLE
12" RCP NW F/L IN 1360.01
12" RCP SE F/L OUT 1359.01
STORM DROP
12" RCP
POL
PATIO
SEED
REFUELER
MAINTENANCE
FACILITY
11.87°
50 0 50 100
SCALE IN FEET
US Army Corps of Engineers
Kansas City District
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
KANSAS CITY, MISSOURI
CORROSION CONTROL FACILITIES - PHASE 1
PROJECT NUMBER PRQE045002P1
MCCONNELL AFB, KANSAS
SITE MAP OF BORINGS
Date: JUNE 2003
Sheet reference number:
CG4.1

LEGEND FOR LOGS OF BORINGS



*Offset from profile of section may be Upstream or Downstream (U or D), Landward or Riverward (LWD or RIV), or Right or Left (R or L) as defined

UNIFIED SOIL CLASSIFICATION SYSTEM

GW	Well graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels or gravel-sand mixtures, little or no fines.
GM	Silty gravels, gravel-sand-silt mixtures.
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well-graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands or gravelly sands, little or no fines.
SM	Silty sands, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts w/ slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays of low plasticity.
OL	Organic silts and organic silty clays of low plasticity.
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
CH	Inorganic clays of high plasticity, fat clay.
OH	Organic clays of medium to high plasticity, organic silts.
Pt	Peat and other highly organic soils.

Classification from actual laboratory tests where LL and PI are shown.
Dual classification, where used, is in accordance with the Unified Soil Classification System.
For details on the Unified Soil Classification System, See Waterways Experiment Station Technical Memorandum No. 3-357 dated March 1953 and revised in 1960.

DEGREE OF WEATHERING

Unweathered: no evidence of any mechanical or chemical alteration.

Slightly weathered: slight discoloration on surface, slight alteration along discontinuities, less than 10 percent of the rock volume altered, and strength substantially unaffected.

Moderately weathered: discoloring evident, surface pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10 to 50 percent of the rock altered, and strength noticeably less than fresh rock.

Highly weathered: entire mass discolored, alteration in nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away, and only a fraction of original strength (with wet strength usually lower than dry strength) retained.

Decomposed: rock reduced to a soil with relict rock texture (saprolite) and generally molded and crumbled by hand.

TM 5-818-1/AFM 88-3, Chap. 7

TYPE OF EXPLORATION

MAP SYMBOL

- ● Vertical boring
- 30 ● Inclined boring showing direction and vertical angle
- ◉ Calyx boring (0.76m diameter or larger)

CODE DESIGNATION

D	Drive sample hole, Split tube sample barrel
C	Core hole
TP	Test pit (includes power auger 0.6m or larger diameter)
U	Undisturbed sample hole
A	Auger hole hand or power auger less than 24" diameter
NS	Not sample (Field Classification from cutting only)
FS	Field Section of outcrop

RQD (Rock Quality Designation)	Description of Rock Quality
0 - 25%	Very Poor
25 - 50%	Poor
50 - 75%	Fair
75 - 90%	Good
90 - 100%	Excellent

BEDROCK UNIT THICKNESS

Parting	< 6mm
Band	6mm to 61mm
Thin Bed	61mm to 152mm
Medium Bed	152mm to 0.3m
Thick Bed	0.3m to 0.61m
Massive	> 0.61m

TERMS FOR CONSISTENCY OF COHESIVE SOIL AND HARDNESS OF BEDROCK

SOIL

Consistency	Estimated Unconfined Compressive Strength
Very soft	<23.95 kPa
Soft	23.95 kPa to 47.9 kPa
Medium	47.9 kPa to 95.8 kPa
Stiff	95.8 kPa to 191.6 kPa
Very stiff	191.6 kPa to 383.2 kPa
Hard	>383.2 kPa

BEDROCK

SCALE OF HARDNESS

Very soft or plastic	Can be indented easily with thumb
Soft	Can be scratched with fingernail
Moderately Hard	Can be scratched easily with knife; cannot be scratched with fingernail
Very Hard	Difficult to scratch with knife; cannot be scratched with knife

ABBREVIATIONS

alt	alternating	dmp	damp	lea	leached	rnd (d)	round, (rounded)
ang	angular	dol (c)	dolomite, (dolomitic)	lig	lignite	sat	saturated
an	anhydrite	ext	extremely	ls	limestone	scat	scattered
ar	argillaceous	f (y)	fine, (finely)	lt	light	sd (y)	sand, (sandy)
bdd	bed, bedded, bedding	fe	iron	lo	loose	sev	several
bdr	bedrock	fld	filled	L.C.	lost core	sh (y)	shale, (shaly)
bky	blocky	fm	firm	L.D.W.	lost drill water	sl (y)	silt
bl	blue	fos (s)	fossil, (fossiliferous)	med	medium	sls	siltstone
bld	boulder	frac (d)	fractures, (fractured)	mic	micaceous	sl	slightly
blk	black	frag (d)	fragments, (fragmented)	min	mineralized	sics	siliceous
brec (d)	breccia, (brecciated)	fri	friable	mod (y)	moderate, (moderately)	slks	slickensides
brk	broken	fsl	fissile	mot	mottled	so	soft
brn	brown	gr	grain	mss	massive	sol (d)	solution, (solutionized)
c	coarse	gra	gradation	mst	moist	ss	sandstone
calc	calcareous	grn	green	mtl	material	st (g)	stained, (staining)
carb	carbonaceous	grv (y)	gravel, (gravelly)	mtx	matrix	stf	stiff
cav	cavity	gry	gray	nod	nodules	sty	stylolitic
cbl	cobble	gyp	gypsum	num	numerous	v	very
cht	chert	ha	high angle	occ (y)	occasional, (occasionally)	vert	vertical
circl	circulation	hd	hard	op	open	vgy	vuggy
cl (y)	clay, (clayey)	hld	healed	or	orange	w	water
cld	closed	hor	horizontal	org	organic	w/	with
cmtd	cemented	inbd	interbedded	par	partially	wth	weathered
col	columnar	incl	inclusions	pit	pit, pitted, pitting	wht	white
conc	concretions	inlam	interlaminated	pl	plastic	x-bdd	crossed-bedded
cong	conglomerate	irr	irregular	pla	platy	xln	crystalline
crm	crumbly	jt (s)	joint, (joints)	pln	plane	y	yellow
d	dense	la	low angle	ptg (s)	parting, (partings)		
dk	dark	lam (d)	laminae, (laminated)	qtz (e)	quartz, (quartzite)		

When used as log symbol first letter is capitalized

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

Designed by: J.M.M.		Date: JUNE 2003
Dwn by: J.M.M.	Ckd by:	Design file no. metriclegend.dgn
Reviewed by:		Drawing code:
Submitted by:		File name: Plot date: Plot scale:
		Rev.

U.S. ARMY ENGINEER DISTRICT
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CORROSION CONTROL FACILITIES - PHASE I
VOLUME I
PROJECT NUMBER PRQE045002P1
MCCONNELL AFB, KANSAS

GEOLOGIC LEGEND AND ABBREVIATIONS

Sheet reference number:
BL1.1

NOTE:
For Geologic Legend and Abbrevations, See Sheet No. BL1.1

US Army Corps of Engineers
Kansas City District

Symbol	Description	Date	Appr.

Designed by:
Dwn by: J.M.M.
Ckd by: J.W.O.
Reviewed by:
Submitted by:
Date: JUNE 2003
Rev.
Design file no.
Drawing code:
File name:
Plot date:
Plot scale:

U.S. ARMY ENGINEER DISTRICT
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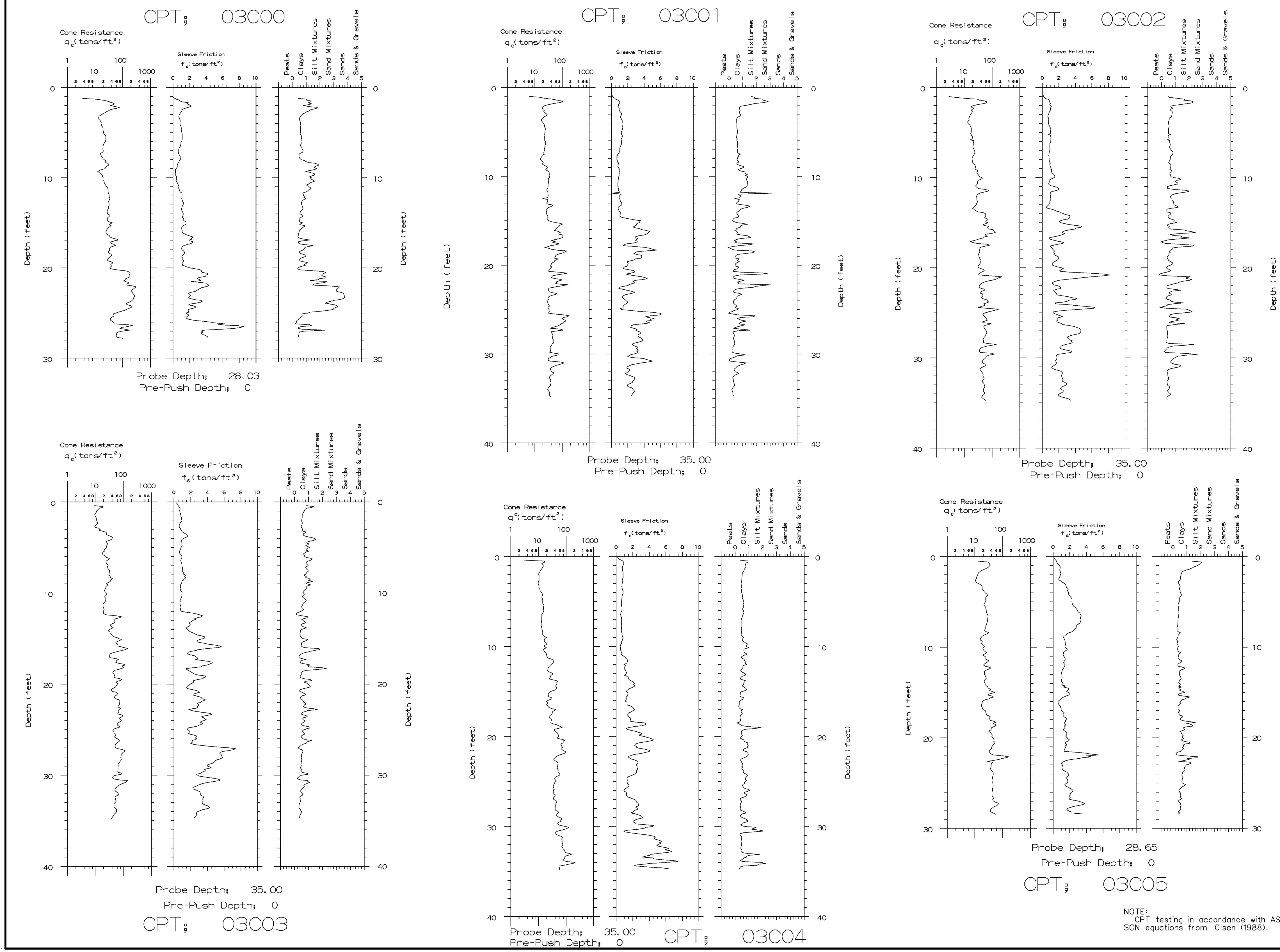
KANSAS CITY, MISSOURI

CORROSION CONTROL FACILITIES - PHASE 1
VOLUME 1
PROJECT NUMBER PRQE045002P1
MCCONNELL AFB, KANSAS

LOGS OF EXPLORATIONS

Sheet reference number:
BL1.2



NOTE:
CPT testing in accordance with ASTM D-3441-98.
SCN equations from Olsen (1988).

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Kansas City District

Symbol	Description	Date	Appr.

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Dwn by: J.M.M.
Ckd by: J.W.O.
Reviewed by:
Submitted by:
Date: JUNE 2003
Rev.
Design file no.
Drawing code:
File name:
Plot date:
Plot scale:

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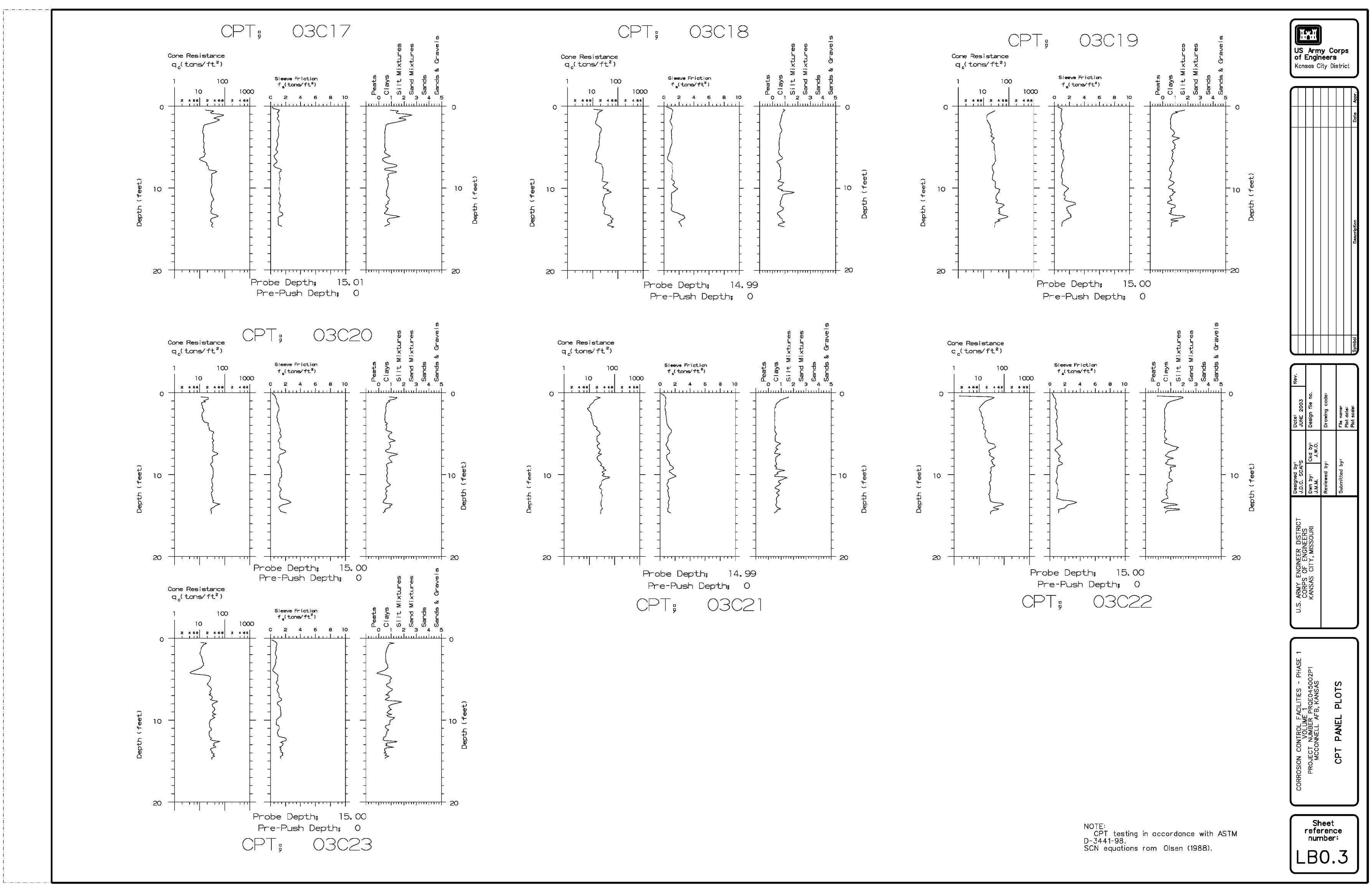
CORROSION CONTROL FACILITIES - PHASE 1
VOLUME 1
PROJECT NUMBER PRQE045002P1
MCCONNELL AFB, KANSAS

CPT PANEL PLOTS

Sheet reference number:
LB0.2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NOTE:
CPT testing in accordance with ASTM D-3441-98.
SCN equations rom Olsen (1988).
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CPT PANEL PLOTS
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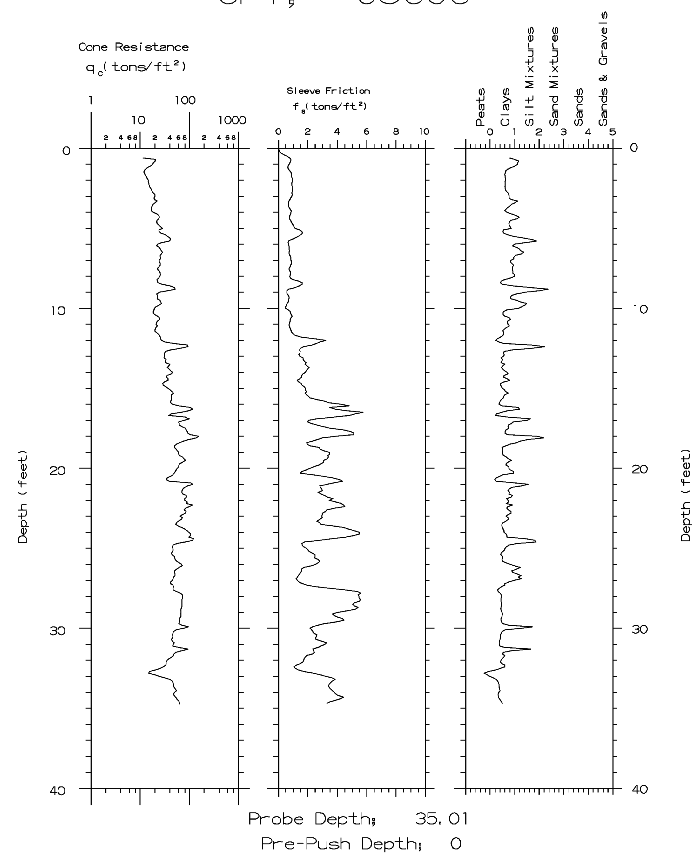

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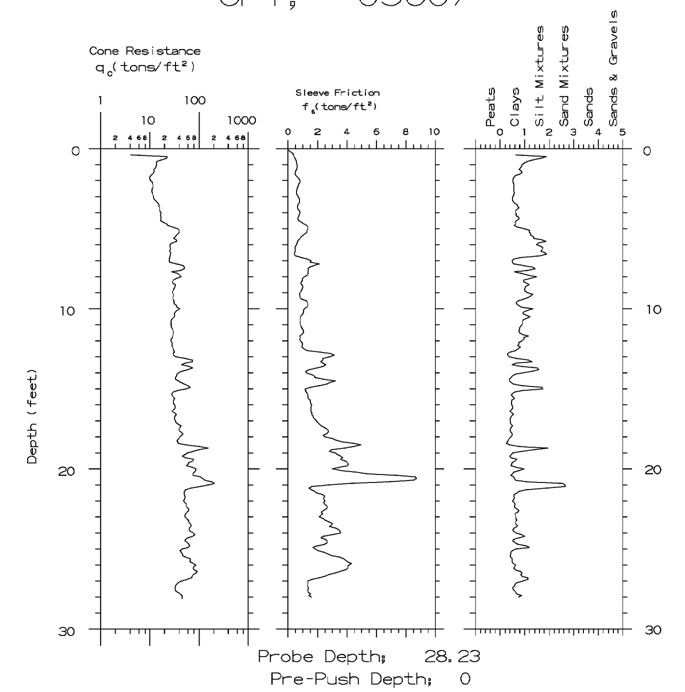

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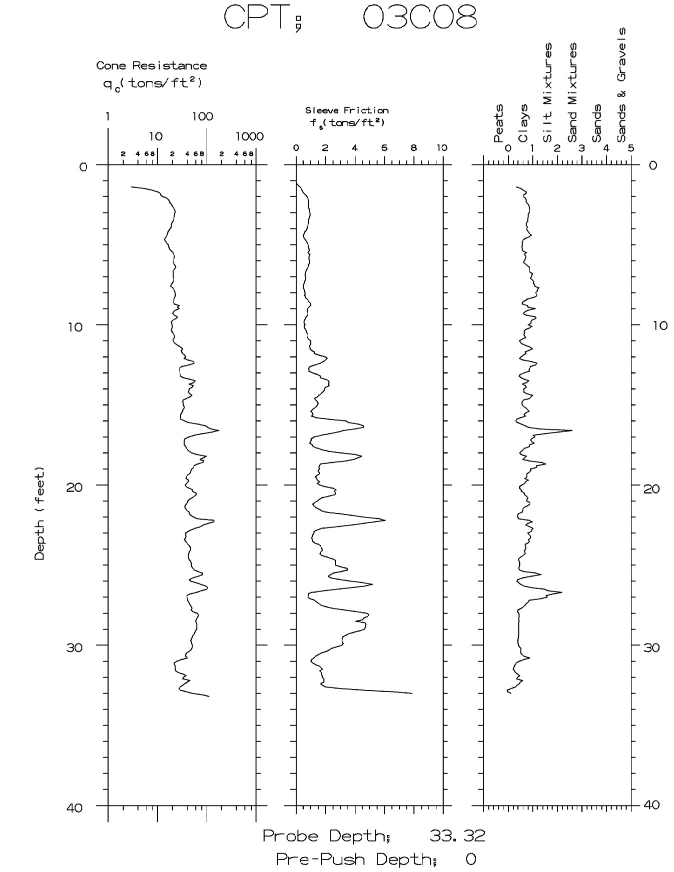

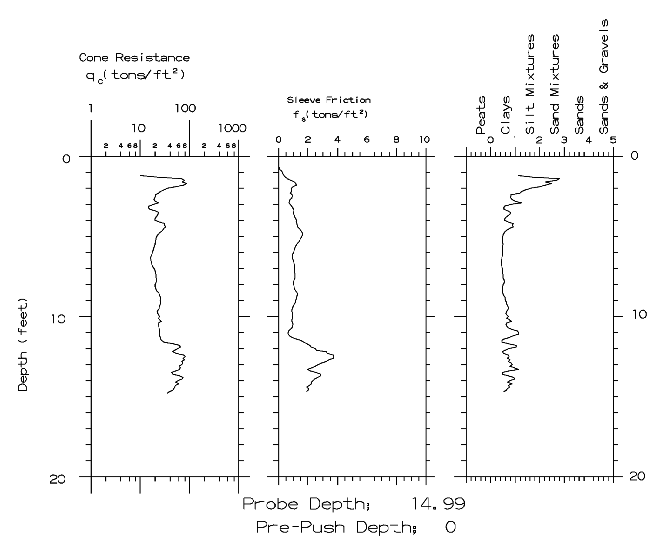

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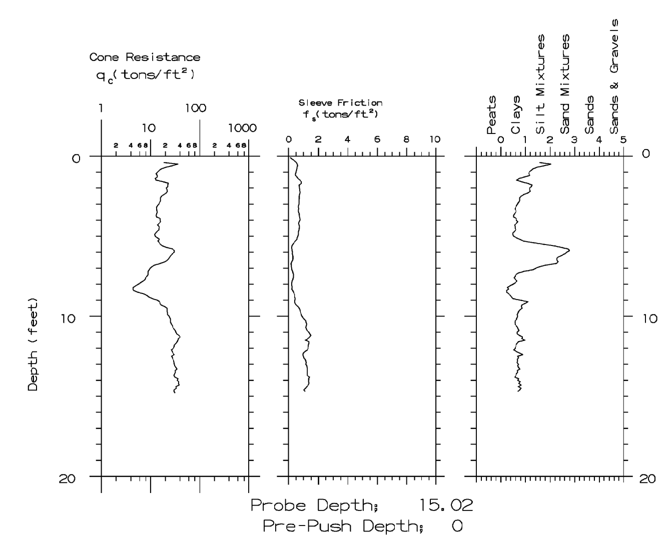

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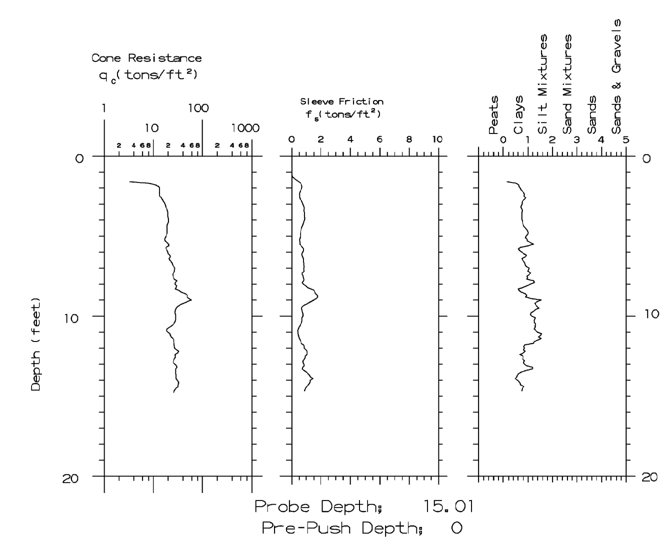

CPT: 03C14

NOTE:
CPT testing in accordance with ASTM D-3441-98.
SCN equations from Olsen (1988).

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Ckd by: J.W.O.
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Design file no.
Drawing code:

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CORROSION CONTROL FACILITIES - PHASE 1
VOLUME 1
PROJECT NUMBER PROE045002P1
MCCONNELL AFB, KANSAS

CPT PANEL PLOTS

Sheet reference number:
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